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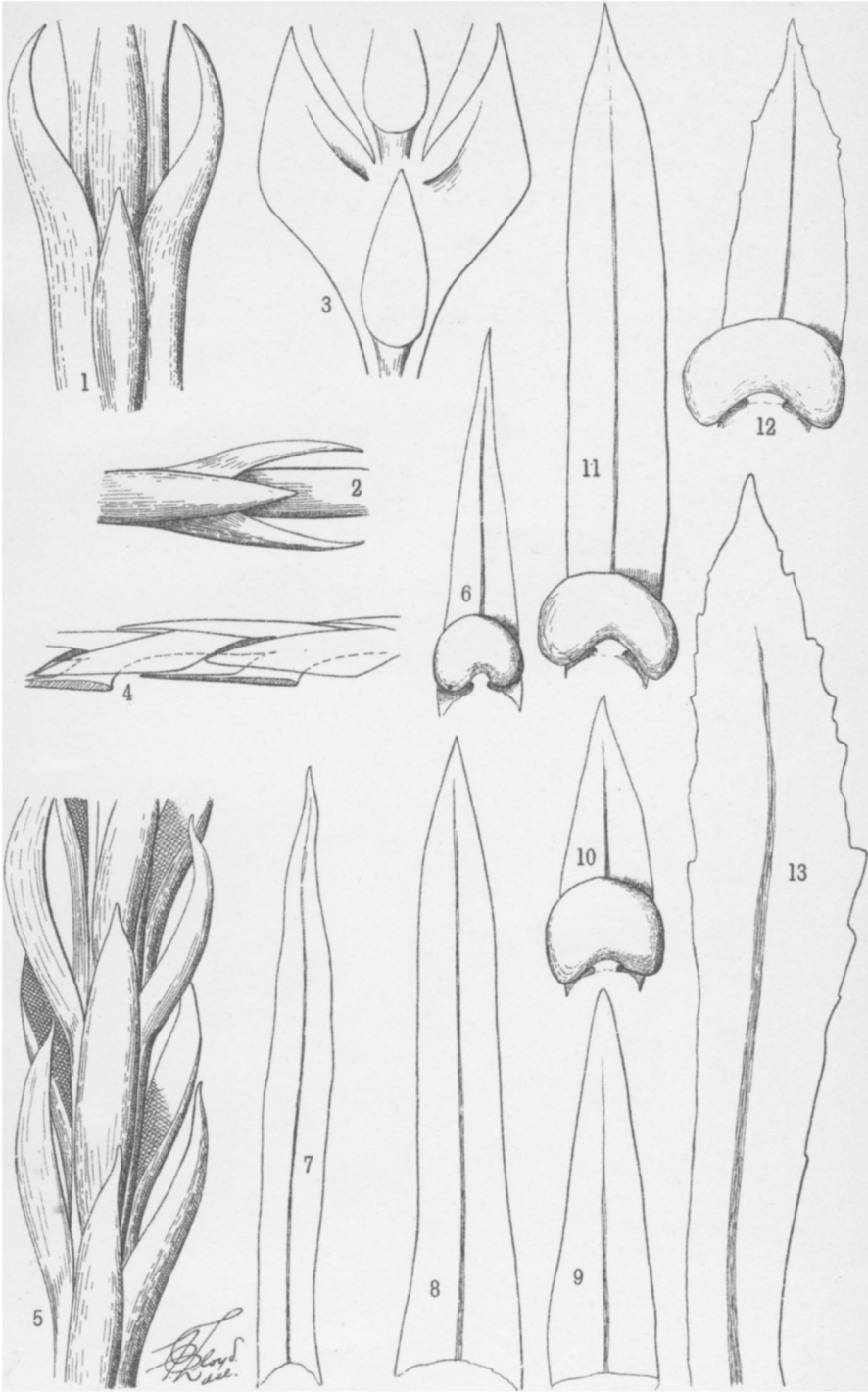
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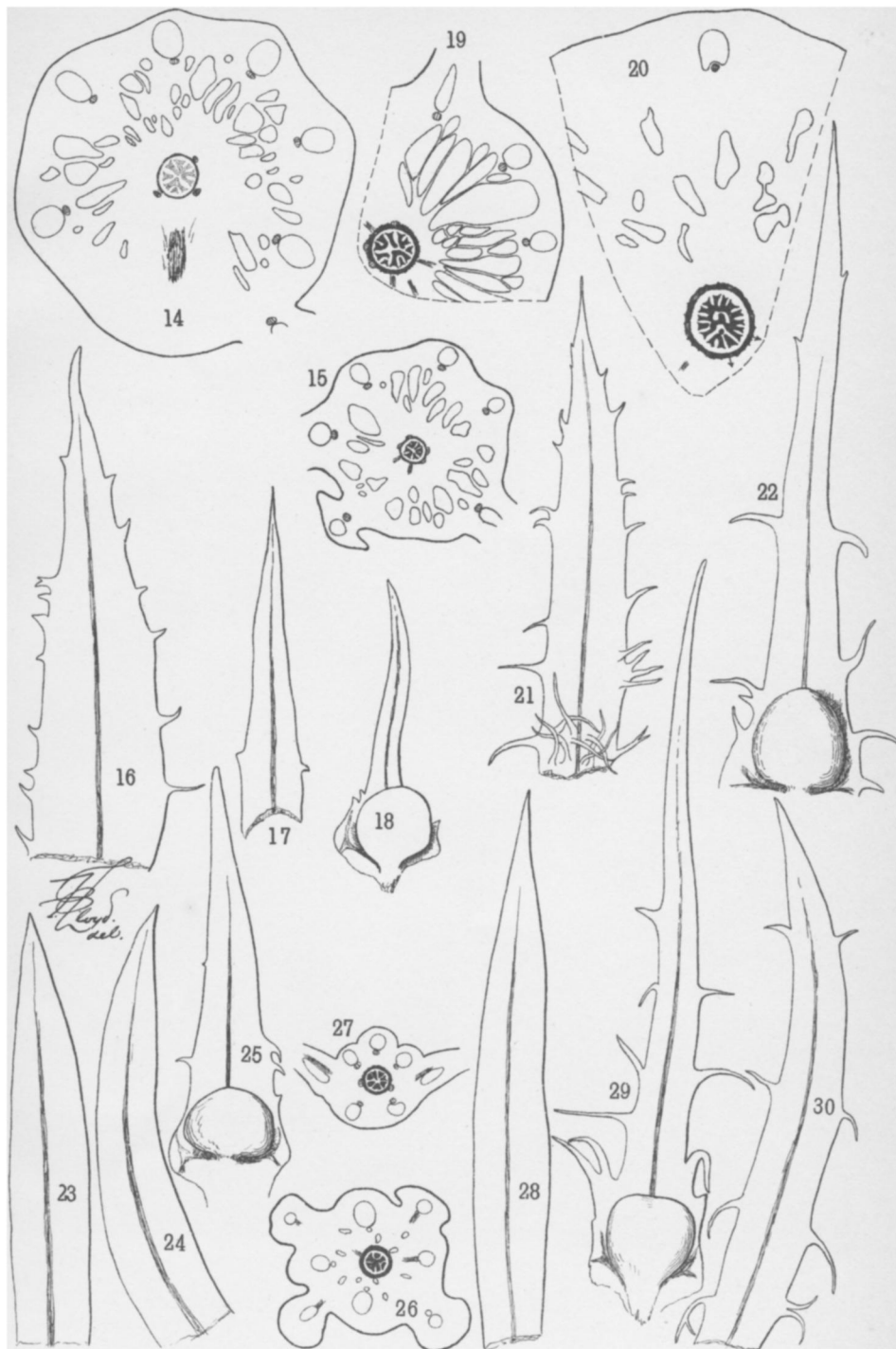
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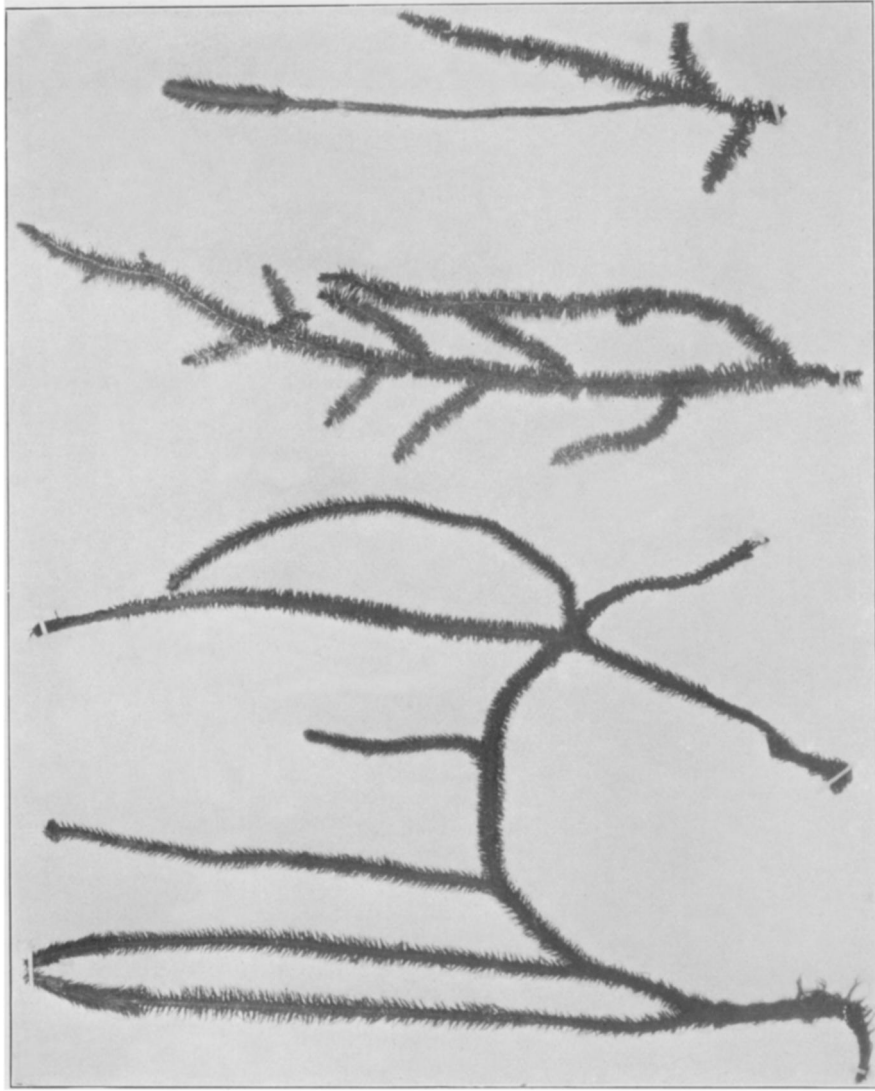
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LLOYD AND UNDERWOOD ON LYCOPODIUM.



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LYCOPodium ALOPECUROIDES AND LYCOPodium PINNATUM.

BULLETIN
OF THE
TORREY BOTANICAL CLUB

APRIL 1900

A Review of the Species of *Lycopodium* of North America

BY FRANCIS E. LLOYD AND LUCIEN M. UNDERWOOD

(WITH PLATES 2, 3, AND 4.)

The genus *Lycopodium* as represented in North America has never received a careful revision. Various forms, mostly varietal, have been described from time to time but the treatment in the various manuals has been mainly that accepted by European writers, commencing with Linnaeus and closing with Milde. Meanwhile a large amount of material has accumulated and we are in the position to give the genus a preliminary survey and bring our knowledge of the American species up to the datum line of modern collections. Much still remains to be done to clear up certain outlying forms and limit the range and variations of certain species and, if possible, determine the causes involved.

The genus *Lycopodium* as treated by Baker* includes ninety-four species and this may be regarded as a very conservative estimate of its extent. Certain features of the range of species are of interest. Five species are circumboreal and are distributed more or less widely throughout the North Temperate Zone. Europe has seven species, viz, *L. Selago*, *imundatum*, *annotinum*, *clavatum*, *alpinum*, *complanatum*, and *chamacyparissus*, all but the second and last being circumboreal and all being found in North America.

In extratropical North America, Baker recognized ten species. To these six must be added, of which three are here recognized as species for the first time. *L. cernuum*, a widely distributed

* Handbook of Fern Allies, 1887.

[Issued 21 April.]

tropical species, also enters our Gulf States. To these Mexico adds seven species, of which *L. serratum*, originally described from Japan, is very doubtfully Mexican, and the rest are species of the West Indies. These islands add six more, of which *L. rigidum* is endemic and the others are species of wider range through tropical America. South America has some forty-one species, of which twenty-nine are endemic and of these twenty-one are confined to the Andean region; two are also African, two North American and the rest are neotropical.

Asia follows with twenty-six species, of which two are endemic in Japan and four in India; of the others, ten (including the five circumboreal species) are also found in the United States, nine in the East Indian Islands, and four in Polynesia. Africa has only thirteen species, of which eight are endemic; of these five are from the mountains of Madagascar. The East Indies have eighteen species, of which four are endemic; ten are species of the adjacent Asiatic mainland, and four are shared with Polynesia. Australasia has thirteen species, of which eight are endemic. Polynesia has nine species, of which only one, *L. polytrichoides*, is endemic in the Hawaiian Islands. Finally, the little island of Tristan d'Acunha has two species, both endemic.

The American species north of Mexico may be separated by the following key:

Plants with mostly upright stems with alternating zones of leaves and sporophylls (strobiles interrupted).

Leaves hollow at their bases and appressed. 1. *L. Selago*.

Leaves flattened at their bases and ultimately more or less reflexed.

Leaves linear or nearly so, entire or very minutely denticulate.

2. *L. porophyllum*.

Leaves distinctly broadest above the middle and erose.

3. *L. lucidulum*.

Plants with more or less extended horizontal stems; the sporophylls aggregated into terminal strobiles.

Sporangia subglobose; sporophylls similar to the foliar leaves.

Sporophylls short (5-6 mm.).

Sporophylls deltoid, mostly entire; plants small.

4. *L. inundatum*.

Sporophylls contracted above the base with a few teeth; plants large.

5. *L. adpressum*.

Sporophylls longer (8-10 mm.), usually much toothed.

Leaves in many rows, radially arranged; stems arching.

6. *L. alopecuroides*.

- Leaves arranged so as to lie in nearly one plane; stems pinnately branching, prostrate. 7. *L. pinnatum*.
- Sporangia transversely compressed, reniform; sporophylls entirely unlike the foliar leaves.
- Leafy stems short (2-15 cm.), prostrate, leaves lying nearly in one plane, none beneath. 8. *L. Carolinianum*.
- Stems with abundant erect or ascending leafy branches.
- Leaves equal, radially arranged (except on the terminal branches of no. 11) in five or more rows.
- Aerial portions dendroid.
- Strobiles few, stout, erect. 11. *L. obscurum*.
- Strobiles numerous, short, nodding. 12. *L. cernuum*.
- Aerial portions extensively trailing, with clustered branches.
- Leaves in five rows; stems and branches slender (2 mm.). 13. *L. Sitchense*.
- Leaves in more than five rows.
- Strobiles solitary, sessile. 9. *L. annotinum*.
- Strobiles 1-several on evident elongate peduncles. 10. *L. clavatum*.
- Leaves in four rows on flattened aerial dorsiventral stems.
- Branches convex on both sides; leaves alike in all four rows. 14. *L. sabinacifolium*.
- Branches with under surface flat or concave.
- Strobiles pedunculate, peduncles usually forked twice.
- Leaves of under row scarcely reduced; terminal. 15. *L. chamaecyparissus*.
- Leaves of under row much reduced to a subulate tip; terminal branches spreading, horizontally fan-shaped. 16. *L. complanatum*.
- Strobiles sessile upon stronger leafy branches; leaves of the under row trowel-shaped. 17. *L. alpinum*.

1. *L. SELAGO* L. Sp. Pl. 1102. 1753

Prostrate portion of stem very short, abundantly rooting, soon curving upward and dichotomously branching to form compact tufts (4-17 cm. high) of vertically placed branches with dense foliage: leaves more or less appressed, or at least upwardly directed, triangular (1.5×4 mm.) to linear-acuminate (0.5 mm. \times 5 mm.) or aciculate (1 mm. \times 8 mm.), broadest at the hollow base, gradually tapering to the acuminate apex, entire: sporophylls shorter than the leaves, triangular: sporangia reniform: plant very frequently gemmiparous.

A boreal and arctic plant, showing a considerable degree of variability. Alaskan material shows a range of variation in its leaves which measure from 2×4 mm. to 1×8 mm., and this in the same habitat, judging from a series of specimens collected by Thos.

Howell, at Yes Bay, Aug. 21, 1895 (N), and another in the same locality Aug. 26, 1895, by M. W. Gorman. Slender-leaved material comes also from Kadiak Is. (B. J. Bretherton, July 23, 1894).

Specimens from the Cascade Mts., Washington, Macdonald Lake, Montana, and Twin Lakes show but little differences, the leaves ranging from $1.5 \times 4-8$ mm. to 0.8 mm. $\times 5$ mm. Specimens from the Northeast, show considerable variation. The forms with the most slender leaves come from the mountains of Vermont, growing in a moist, shaded habitat (A. J. Grout, Mt. Mansfield). These facts, together with the variability found in the moist climate off the Alaskan coast, would indicate that the slender form of the leaf is induced by a wet, shaded habitat.

Other specimens collected by Dr. Grout, at Mt. Mansfield, whether in the shade or not is not stated, have somewhat broader leaves. Plants of Mr. G. G. Hinsdale's collection of the "summit of Mt. Mansfield" (1893) are typical in form, with shorter and broader leaves.

Distribution: Greenland, Labrador, Newfoundland, Maine, New Hampshire, Vermont, New York, North Carolina, Idaho, Washington, Alaska, St. George Island (Behring Sea). A plant with strongly reflexed leaves but otherwise not differing from *L. Selago* is represented by specimens as follows:

IDAHO: Little North Fork Basin "mountain woods," Sept., 1895, J. B. Leiberger (N).

ALASKA: Sitka, F. Bischoff (N).

CANADA: Mud Lake, July, 1891, F. F. Wood (N).

2. *L. porophilum* sp. nov.

Prostrate portion of stems short, abundantly rooting, curving upwards, then dichotomously branching 1-3 times to form a rather dense tuft (4-10 cm. high) of vertical stems, densely clothed with spreading or reflexed leaves: leaves ($7-9$ mm. $\times 1$ mm.) very slightly broadened above the middle and similarly contracted toward the base, those between the strobilar regions shorter (6-7 mm.), broadest at the base but very gradually tapering, entire or very minutely denticulate: sporangia compressed reniform: sporophylls minutely denticulate above the middle or entire, acuminate ($4-5$ mm. $\times 1$ mm. wide at base): plant often gemmiparous.

A plant intermediate in habit between *L. lucidulum* and *L. Selago*,

having the leaves spreading or somewhat reflexed, with the alternation of long leaves and short sporophylls. Leaves not hollow at the base but flat as in *L. lucidulum*.

Of very limited range so far as known at present, and confined apparently to sandstone rocks. The plant varies no more than *L. lucidulum*, both differing in this respect from *L. Selago*.

INDIANA: Fern, Putnam Co., Oct., 1891,* L. M. Underwood (U): type.

WISCONSIN: Dells of the Wisconsin, Aug. 19, 1893, L. M. Underwood (U).

KENTUCKY: Mountains, Warren Co., "on the face of sandstone cliffs, June, 1898," S. F. Price (U). Green River, Warren Co., "on a sandstone cliff," June, 1896, S. F. Price (U).

ALABAMA: Winston Co. "under projecting sandstone rocks near Sipsey River," 1 June, 1896, L. M. Underwood (U). This plant differs slightly from the other and more northerly ones in having narrower sporangia.

3. *L. LUCIDULUM* Michx. Fl. Bor. Am. 2: 284. 1803

Prostate portion of stems longer (5–15 cm.), frequently rooting, curving upward and dichotomously branching 1–3 times to form a loose cluster (10–20 cm. high) of a few densely leafy vertical stems, or the stems occasionally occur single: leaves reflexed (8–11 mm. \times 1.5–2 mm.), linear-obovate, broadest above the middle, from which point they gradually taper to the 1 mm. wide base; margin erose denticulate above the middle, acute: sporophylls 3.5–8.5 mm. \times 1.2–1.5 mm., linear, acute, entire or sometimes slightly denticulate: sporangia depressed reniform: plant often gemmiparous.

The rhythmic production of sporangia and the resulting alternation of long leaves and short sporophylls gives the foliage a wavy outline quite characteristic of this plant, with its shining dark green leaves.

Habitat in forests, more commonly in low ground.

Distribution: Newfoundland, Prince Edward Island, New Brunswick, Maine, New Hampshire, Vermont, Ontario, Massachu-

* At the Indiana station this species grows with *L. lucidulum*, the latter always in the low swampy ground bordering the small streams, while this species grows along the narrow ledges of the overhanging sandstone rocks. The range of *L. lucidulum* also includes the other stations.

setts, Connecticut, New York, New Jersey, Pennsylvania Maryland, Virginia, West Virginia, Tennessee, North Carolina, South Carolina, Indiana, Illinois, Missouri, Minnesota, Michigan, Wisconsin.

4. *L. INUNDATUM* L. Sp. Pl. 1102. 1753

Stems creeping horizontally or arching, about 10 cm. long, simple or once or twice forking, slender, 1.5 mm. in diameter, roots produced toward the end of the annual growth : leaves 5 mm. \times 0.8 mm. linear-lanceolate, entire, acute, curved upward ; those of the peduncles straight, entire, more slender and tapering : peduncles 0.5–6 cm. long or the strobiles sessile : strobiles 0.8–4 cm. long : sporophylls about 5–6 mm. long, 1.5 mm. wide at the base, triangular, usually entire or sometimes toothed just above the base, then somewhat contracted : sporangia subglobose. European material shows denticulation of the sporophylls.

Specimens have been examined as follows :

NEWFOUNDLAND : Bally Haily Bog, St. John, Aug., 1894, B. L. Robinson and H. von Schrenk, no. 135 (N, G).*

NOVA SCOTIA : July, 1884, H. T. Meenan (G).

PRINCE EDWARD ISLAND : 1888, J. Macoun (G).

CAPE BRETON ISLAND : July, 1883, J. Macoun (G).

NEW BRUNSWICK : 1868, J. Fowler (G) ; Bass River, "rare," Oct., 1875, J. Fowler (N).

MAINE : Bog, Great Cranberry Isle, Sept. 1891, E. L. Rand (U) ; Mount Desert Island, Sept., 1890, E. L. Rand (U) ; Dead River, M. L. Fernald, 497 (G) ; Oxford Co., J. A. Allen (G, N).

ONTARIO : Hastings Co., July, 1876, J. Macoun (C).

NEW HAMPSHIRE : Mt. Willey, Aug., 1878 (Y) ; White Mts., E. Tuckerman (C, G) ; Seabrook, Sept., 1895, A. A. Eaton (N).

VERMONT : Hartland, Sept., 1893, W. W. Eggleston (C).

CONNECTICUT : Southington, Sept., 1898, C. H. Bissell (Y).

MASSACHUSETTS : Berkshire Co., July, 1890, A. K. Harrison (U) ; South Hadley, Oct., 1888, Alice Carter (U) ; Sudbury, Nov., 1890, L. M. Underwood (U).

NEW JERSEY : C. F. Austin (U).

PENNSYLVANIA : Luzerne Co., Sept., 1890. Small and Heller

* The letters N, G, C, Y, and U, refer to the National, Gray, Co'umbia, New York Botanical Garden, and Underwood herbaria in which the specimen cited may be found.

(N); Pocono Mt., T. Green (G); Tobyhanna, July, 1889, N. L. Britton (C).

NEW YORK: Herkimer Co., J. A. Paine (G).

ILLINOIS: Evanston, 1884, H. L. Boltwood (G).

MICHIGAN: Keeweenaw Co., 1888, O. A. Farwell (G).

BRITISH COLUMBIA: Vancouver, Aug., 1893, J. Macoun (N).

ALASKA: Short Bay, July, 1895, M. W. Gorman, "wet bogs in upland meadows" (C, N); Aug., 1895, T. Howell, no. 1731 (Y).

4a. *L. inundatum* BIGELOVII Tuck. Am. Jour. Sci. 45:

47. 1843*

A larger plant with longer and more abundantly branching slender stems with slightly longer leaves which are entire or toothed. Sporophylls as in *L. inundatum*.

CAPE BRETON ISLAND: Peat bog, North Sidney, 1883, J. Macoun (C).

VERMONT: Stirling Mt., Aug., 1882, O. H. Butler (C); Stratton, July, 1894, A. J. Grout (U).

NOVA SCOTIA: Grand Lake, 1879, E. G. Knight (C).

MASSACHUSETTS: Ipswich, Oakes (C); New Bedford, T. A. Green (C); Plymouth, Oakes and Tuckerman (C); Tuckerman (G); Essex; Sept., 1896, A. A. Eaton (U); Oakes, "in Sphagnosis humidis Novae Angliae" (N).

RHODE ISLAND: Providence, "low, grassy land, July, 1892," J. F. Collins.

NEW JERSEY: Egg Harbor, E. G. Knight (C); Quaker Bridge, June 17, 1890, F. E. Lloyd (Y).

5. *L. adpressum* (Chapman)

L. inundatum, var. *elongatum* Chapm. Fl. So. States, ed. 2, 671. 1883. (Not *L. elongatum* Sw.)

L. inundatum, var. *adpressum* Chapm. Fl. So. States, ed. 2, 671. 1883.

L. alopecuroides var. *elongatum* Chapm. Fl. So. States, ed. 3, 638. 1897.

* The original description reads as follows: β *Bigelovii* (mihi): majus, ramis subramosis elongatis, foliis acuminatis sparsim denticulatis s. integris. *L. Carolinianum* Bigel. Fl. Bost. p. 384.

In the same paper *L. alopecuroides* (L.) follows as the var. γ of *Lycopodium inundatum*.

L. alopecuroides, var. *adpressum* Chapm. Fl. So. States, ed. 3, 638. 1897.

Stems prostrate and frequently rooting or slightly arching and rooting toward the end, 18–40 cm. long, simple or occasionally pinnately branching, thick (about 3 mm. in diameter): leaves 6–7 mm. long by 2 mm. broad, thicker and more rigid than in the last, lanceolate-acuminate, upwardly curving, the margin irregularly toothed, the teeth often compound below the middle of the leaf: peduncles 10–25 cm. long usually tall, slender (1.5–2.5 mm. in diameter), leafy with more or less appressed subulate-toothed leaves below and similar entire leaves above: strobiles narrow, about 3 mm. in diameter, and 1.8–7 cm. long: sporophylls 1 mm. \times 5–6 mm. with a broad base, suddenly contracted above into a narrow subulate apex, usually more or less toothed near the base: sporangia subglobose.

Readily distinguishable from *L. inundatum* by the much thicker stems, toothed leaves, tall peduncles and long narrow spikes.

An abnormal condition occurs in which the strobiles fail to develop and the branches rise to an unusual height (35 cm.). Lake Worth, Florida, L. M. Underwood (U). One peduncle on the same sheet bears a strobile of unusual size (11 cm.)

In the northern part of its range, this plant is much smaller and is difficult to distinguish from *L. inundatum* Bigelovii, from which, however, it differs in its thicker stem, in the shape of its leaves, and in the degree of their denticulation which, however, is constant in the leaves of the prostrate stems, but the constancy frequently fails in the peduncular leaves.

Although the more southern plant is here regarded as a distinct species, and is believed to be entitled to such rank, it must be admitted that from the true boreal species, *L. inundatum*, to the large southern *L. adpressum* there are many forms which on account of variations in size of stem, denticulation and variations in the size and shape of leaf and sporophyll are difficult to place. It will, however, be found convenient to hold to the above arrangement as tentative in the hope that further and more careful field observations will help to clear up the whole matter. It is further of great interest to note that a single species which in Europe shows little variability is in America only a representative of a plexus of forms ranging from that species at one end of the series to the extremely curious plant, *L. alopecuroides*, at the other.

Specimens have been examined as follows :

MASSACHUSETTS: Plum Island, Newburyport, Oct., 1896, A. A. Eaton (U); Plymouth, Oakes (C, N).

RHODE ISLAND: Providence, July, 1892, J. F. Collins (N).

CONNECTICUT: New Haven, 1859, D. C. Eaton (C).

NEW YORK: Babylon, L. I., July and Sept., 1898, W. N. Clute (Y); Forbell's Landing, L. I., Oct., 1890, M. Timmerman (C).

NEW JERSEY: Hospitality Bridge, Aug., 1884, C. A. Gross (Y); Closter, Sept., 1865, C. F. Austin (U, C); Tom's River, July, 1898, W. N. Clute (Y); Ocean Co., Aug., 1889, N. L. Britton (C).

MARYLAND: Ammendale, May, 1897, G. A. Miller (N); Anne Arundel Co., Oct., 1894, and Sept., 1895, C. E. Walters (N); Branchville, Sept., 1899, W. R. Maxon (U).

DISTRICT OF COLUMBIA: near Washington, Sept., 1885, F. H. Knowlton (U).

VIRGINIA: Portsmouth, July, 1892, N. L. and E. G. Britton and A. M. Vail (C); Fredericksburg, Aug., 1893, T. C. Porter (C).

NORTH CAROLINA: Rowan Co., J. K. Small, Aug., 1894 (N, C); Southeastern N. Car., W. W. Ashe (N).

LOUISIANA: Lake Charles, Aug., 1897, S. M. Tracy (U).

ALABAMA: L. F. Ward, 1892 (N); Mobile, 1877, C. Mohr, (N).

GEORGIA: Sumter Co., Dec., 1895 and 1896, R. M. Harper (Y).

FLORIDA: Lake Worth, Mar., 1891, L. M. Underwood (U); Leesburg, 1891, L. M. Underwood (U); Jacksonville, Mrs. F. A. Curtis (U, G); Everglades, Mar., 1892, J. H. Simpson (N, G); "*L. inundatum* var. *elongatum*, S. Fl. ined." Herb. Chapman (N) (and similar sheet in C); Palma Sola Bay, Aug., 1890, J. H. Simpson (N); among these one specimen shows an entire absence of teeth on the leaves in one region of the stem, while the rest of the specimens on the sheet have normal leaves; the specimen looks as if it had grown partly submerged.

6. *L. pinnatum* (Chapman)

L. inundatum, var. *pinnatum* Chapman, Fl. So. States, ed. 2, 671. 1883.

L. alopecuroides, var. *pinnatum* Chapman, Fl. So. States, ed. 3, 638. 1897.

Stems pinnately branching, elongate (20–30 cm.) and very slender (1–2 mm.) with evident dorsiventral character: leaves (8–9 mm. \times 1 mm.) thin, linear-lanceolate, slightly curved, long-toothed, those of the upper side smaller, all somewhat contracted at the base; those of the peduncles similar but more gradually tapering to the apex: peduncles 25–40 cm. long, slender (1–2 mm. in diam.), very leafy: strobiles 3–12 cm. long, 5 mm. thick, with spreading sporophylls, similar to the peduncular leaves, but longer and more gradually tapering: sporangia sub-globose.

This very distinct species was made first a variety of *L. inundatum* and later of *L. alopecuroides*, but its dorsiventral habit and other marked characters clearly distinguish it from both; it is very clearly recognized. The lateral expanse of foliage ranges from 16 to 18 mm. Very rarely the denticulation appears to be nearly absent, as in a specimen seen from Jacksonville, Fla.

Specimens have been examined as follows:

MISSISSIPPI: Jackson, July, 1896, C. L. Pollard (N); Ocean Springs, June, 1896, L. M. Underwood (U); Aug., 1889, F. S. Earle (U); Aug., 1898, S. M. Tracy (Y).

ALABAMA: Spring Hill, Aug., 1897, B. F. Bush, 159 and 151 (Y, N); Auburn, Oct., 1896, C. F. Baker (C).

GEORGIA: McIntosh Co., June, 1895, J. K. Small (C).

FLORIDA: "Damp Pine Barrens" in Jacksonville, Sept., 1896, A. H. Curtis, nos. 3788 (C, N), 5783 (G); S. Fla., Herb. Chapman (N, C).

7. *L. ALOPECUROIDES* L. Sp. Pl. 1102. 1753

Stems elongate (50 cm. or more), thick (3–4 mm.), with an arching habit, rooting near the end, the vertical peduncles arising from the arches, densely leafy: leaves (5–7 mm. \times 0.6–1.2 mm.) thicker than in the last, lanceolate-acuminate, spinulose on the sides of the stem to linear lanceolate on the upper and lower side, margin long toothed, and the lower surface near the base usually very hairy, especially on sides of the stem: those of the peduncles similar: peduncles long (20–30 cm.) densely leafy and scarcely distinguishable from the stems: strobiles 2–10.5 cm. long, 5 cm. thick, when ripe with reflexed sporophylls, these similar to the peduncular leaves but not hairy on the underside,

longer (10–11 mm.), more gradually tapering and similar to those of the last species.

A number of mature specimens we have seen lead us to believe that the reflexion of the sporophylls at maturity is a constant feature in this species, but not in *L. pinnatum*. Further field observations are necessary to establish or refute this belief.

Specimens have been examined as follows :

NEW YORK : Babylon, L. I., Sept., 1898, W. N. Clute (Y).

NEW JERSEY : Landisville, C. A. Gross (Y), Hospitality Bridge, Sept., 1887, C. A. Gross (N), Pines, C. F. Austin (C).

DELAWARE : Ellendale, Sept., 1891, W. M. Canby (N).

NORTH CAROLINA : Hendersonville, Sept., 1898, Biltmore Herb., 595A (Y) ; Wilmington "in *Dionaea* savannah," June 25, 1890, F. V. Coville (N).

SOUTH CAROLINA : Santee Canal, Sept., Ravenel (G).

MISSISSIPPI : Ocean Springs, June, 1896, L. M. Underwood (C), F. S. Earle, Aug., 1889 (U) ; Biloxi, Aug., 1898, S. M. Tracy (U).

ALABAMA : Spring Hill, Aug., 1897, B. F. Bush, 153 (Y N).

GEORGIA : Lowndes Co., June, 1895, J. K. Small (C) ; 1840, A. Gray (C).

FLORIDA : Jacksonville, "moist pine barrens," Nov., 1894, A. H. Curtis, no. 5357 (C) ; Lake Co., Aug., 1894, G. V. Nash (N, C) ; S. Fla., Chapman (N, C) ; Appalachicola, Aug., 1891, Chapman (N, G) ; Hibernia, March, 1869, W. N. Canby (G) ; T. W. Webster (Y).

The stems of the four species just described differ not a little in certain details of stem structure. Certain features they all possess in common with one exception, noted below ; these are more especially the gum canals and air spaces which occur in the cortex. A single gum canal occurs on the outside of each leaf trace, and runs up into the leaf. The air spaces are irregular schizogenous cavities in the cortex ; they are very small, are few in number in *L. inundatum* and are absent in *L. pinnatum* ; in *L. adpressum* they are more numerous and larger than in *L. inundatum*, while in *L. alopecuroides* they attain their maximum development both in size and number. Indeed, the cortex in this handsome plant is little more than a honeycomb, the walls of which are com-

posed of a single layer of parenchyma cells. All four species store up toward the end of the growing season a large amount of reserve food, for the most part starch, and as a result of this habit the terminal portions of their horizontal stems become considerably thickened. The stele is also enlarged in these parts, and the air spaces are very much reduced, more so in *L. alopecuroides*, however, than in the others. These terminal parts of the stems serve to perpetuate the plants during the winter. There is also not a little difference in the size of the stems, *L. pinnatum* having the smallest, with *L. inundatum* next in order; *L. alopecuroides* has the thickest stem of the four.

8. *L. CAROLINIANUM* L. Sp. Pl. 1104. 1753

Stems short (1–15 cm.), slender (1–1.5 mm. diam.), prostrate, pinnately branching, rooting occasionally from the under side; leaves strongly dimorphic, the apparently lateral ones large (5–6 mm. \times 1.5–2 mm.), ovate-lanceolate, falcate, recurved, broadest below the middle, with a midrib asymmetrically placed, thin, entire, acute: leaves of the upper side smaller (3–4 mm. \times 0.8–1 mm.), subulate with a broad base: leaves of the peduncles reduced to small (2–3 mm.) subulate more or less appressed bracts: peduncles 5–22 cm. long, slender, with few usually whorled or scattered bracts: strobiles (1–5 cm. long \times 2–2.5 mm.) with sporophylls (2 \times 3 mm.), these triangular or somewhat contracted above the base, margin entire or erose: *sporangia* subglobose.

Habitat: In wet places, swamps.

A plant with a very pronounced dorsiventral character, in which the apparently large lateral leaves are really leaves of the under side, giving it a superficial resemblance to a liverwort. Although similar in some regards to *L. inundatum* and *L. pinnatum*, it is to be separated from them by its above just described dorsiventral character.

Specimens from the United States have been examined as follows:

NEW JERSEY: Atsion, Aug., 1897, J. A. Allen (G); Leed's Point, 1833, A. Gray (G); Quaker Bridge (N); Toms River, 1894, L. H. Lighthipe (?); Egg Harbor, Sept., 1884, L. M. Underwood (U); Hospitality Bridge, Aug., 1883, C. A. Gross (strobile 1.5 cm. long) (Y); Toms River, July, 1898, W. N. Clute (Y).

NORTH CAROLINA: Wilmington (G).

SOUTH CAROLINA: Aiken, Ravenel (N).

GEORGIA: Sumter Co., June, 1897, R. M. Harper (Y).

MISSISSIPPI: Ocean Springs, 1896, C. L. Pollard (N).

FLORIDA: Apalachicola, July, 1891; Chap. Herb. (G); Apalachicola, 1856, Chapman (strobile 14 cm. long) (C); Jacksonville, A. H. Curtis, 1896 (G); Eustis, G. V. Nash, July, 1894, no. 1451 (G, C); Lake Worth, Mar., 1891, L. M. Underwood (U); Orange Co., July, 1894, S. L. Lewton (Y); T. W. Webster (strobile 14 cm. long) (Y).

The species also extends through the tropics to Brazil.

9. *L. ANNOTINUM* L. Sp. Pl. 1103. 1753

Prostrate stems a meter or more long, extensively creeping along the surface, very rarely pinnately branching, stiff, rooting, leafy, with frequent aerial branches 15–25 cm. tall, which fork 1–3 times or not at all, producing slender erect branches, which are usually strobile-bearing: leaves 5–8.5 mm. \times 1–1.5 mm., in 8 rows, uniform in shape throughout the plant, longest in the aerial parts where they spread horizontally or are finally somewhat reflexed with upwardly curving apices, lanceolate to linear-lanceolate, broadest at or above the middle, serrulate, acute or pungent: strobiles sessile upon the leafy vertical branches, thick (4 mm. \times 1–3 cm.), with broadly ovate sporophylls, the latter with erose margins and subulate tips.

The so-called var. *pungens* with stiffer, shorter more erect leaves is a condition not at all confined to mountain forms.

Distribution: Alaska, Washington, Idaho, Montana, Lake Winnepeg, Colorado, Minnesota, Michigan, Pennsylvania, New York, Massachusetts, Vermont, New Hampshire, Maine, Newfoundland, Greenland.

10. *L. CLAVATUM* L. Sp. Pl. 1100. 1753

Prostrate stems 1–4 meters long, creeping extensively along the surface of the ground, very leafy, sparingly rooting, branching horizontally, with frequent aerial stems which are immediately ascending or at first prostrate, then ascending, producing pinnate branches of the second and third order, lax, some of them producing stout peduncles, 7–12 cm. long, with subulate, bristle-tipped whorled or scattered bracts and producing one, or frequently 3–4 strobiles: leaves linear or somewhat expanded at the mid-

dle, acute, denticulate, bristle-tipped, entire or minutely denticulate, those of the horizontal stems strongly denticulate : strobiles with deltoid sporophylls, erose, subulate tipped : sporangia reniform.

A widespread species or complex of species extending according to Baker's treatment* throughout the arctic and alpine zones of both hemispheres and in the mountains of tropical Asia, Africa and Polynesia. He reduces nine species under this name several of which will be found to be distinct. Some of the specimens from the Northwest and Alaska are very unlike the eastern forms and usually have much more forked strobiles and are commonly devoid of bristle tips to the leaves. In some particulars they resemble the east Asiatic and Siberian forms with larger suites of which they should be compared than are available in this country. Meanwhile careful field notes of the forms occurring from Oregon northward to Alaska are desirable.

Distribution : Labrador, Newfoundland, Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, Pennsylvania, Quebec, Ontario, Michigan, Wisconsin, Minnesota, Saskatchewan, Oregon, Washington, Alaska.

A large proportion of the material from the Northwest which has been examined differs materially from the eastern plant, the most striking feature being the absence of the bristle tip to the leaf. Plants from Alaska show a dwarfed condition, with shorter peduncles. The distribution of the plant in the Northwest is of interest and is shown here in more detail :

WASHINGTON : In damp woods, 4000–5000 ft. alt., Skamania Co., Aug. 28, 1890, W. N. Suksdorf, no. 1030 (C, G, N); 1889, G. R. Vasey, no. 32 (N, G); deep woods, Pierce Co., Aug., 1895, C. V. Piper (G); forest, Mt. Rainier Range, U. S. South Pac. Exp. Exped., 1838–42, Klickitat Pass, F. E. Lloyd (Y).

OREGON : Base of Mt. Hood, Nov., 1870, G. Howell (G); Bridal Vail, Aug., 1897, J. E. Kirkwood (Y).

BRITISH COLUMBIA : Mt. Benson, N. I., July 10, 1893, J. Macoun (N); 1859, Lyall, no. 1318 (C).

ALASKA : 1879, C. M. Turner (N) and 1881 (G); Kadiak Is., June 27, 1896, B. J. Bretherton (N).

The Mexican and Central American representatives of this spe-

* Handbook of Fern Allies, p. 26.

cies differ in having stems which merge into the peduncles as shown by the gradual reduction of the leaves from the typical foliar condition to that of small bracts, or, again, the peduncles may be entirely leafy. This is probably due to the influence of less abrupt seasonal changes. The forkings of the peduncles are sometimes more distant, and the whole plant has a more lax habit. Specimens have been examined from the following localities:

JAMAICA: Blue Mt. Peak, Dec. 14, 1890, A. S. Hitchcock (U); 1885 (N).

MEXICO: Orizaba, 1853 (C), Jalapa; Vera Cruz, 4000–5000 feet, Dec., 1894, C. L. Smith, no. 2119 (N); Orizaba, 1855 Müller, no. 362 (C); Manzanilla, Mt. Chiapa, 2000 meters, Aug., 1890, J. N. Rovirosa (C).

GUATEMALA: San Miguel Uspantán, Quiche, 7000 feet, April, 1892, Heyde and Lux (C, N).

NICARAGUA: 1853–6, C. Wright (N).

11. *L. OBSCURUM* L. Sp. Pl. 1102. 1753

L. dendroideum Michx. Fl. Bor. Am. 2: 282. 1803.

Horizontal stems extensively creeping underground, giving off single vertical stems which by repeatedly branching produce a bushy mass of foliage 12–25 cm. high: leaves spreading and upwardly curving, linear-lanceolate and twisted, especially above so as to lie in a vertical plane, acute, mucronate, on the lower branches in 8 rows, on the terminal in 6 rows; strobiles sessile: sporophylls broadly ovate, papery and erose-margined, acuminate with a subulate apex: sporangia reniform.

The form with a tendency to dorsiventrality in the terminal branches the upper and lower rows of leaves being shortened and appressed, is supposed to be the one to which the Linnaean name was originally given. It is unfortunate that Michaux's appropriate name could not hold for this miniature tree-like species.

Distribution: Newfoundland, Maine, Quebec, Ontario, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, Kentucky, Tennessee, Ohio, Minnesota, Michigan, Montana, Alaska.

12. *L. CERNUUM* L. Sp. Pl. 1103. 1753

Stems 20–35 cm. long, procumbent or arching, with clustered roots at points of contact with the ground, branching often in

different planes, the terminal branchlets often strobile-bearing and nodding: leaves 3–5 mm. long, cylindric, slender, subulate, spreading and upwardly curving: strobiles sessile, 5 mm. long, with small sporophylls (1.5 mm. \times 8 mm.) ovate-acuminate, thin with deeply fringed margins: sporangia minute, spherical, transversely compressed.

The plant of the Gulf region seems to differ in no respect from the more tropical form except in size, in the less pronounced upright habit, and in the length of the strobiles.

Specimens from the United States have been examined as follows:

MISSISSIPPI: Ocean Springs, July, 1889, F. S. Earle (U).

ALABAMA: "Springy clay banks," Mobile Co., June, 1889, C. Mohr (U, G, N); Spring Hill, "common in swamp," Aug., 1897, B. F. Bush (Y).

FLORIDA: Lake City, Dec., 1894, F. C. Straub, no. 42 (G); Prairie Creek, A. P. Garber (C, G, N); "moist pine barrens," near Jacksonville, Mrs. A. Curtiss (G); E. Fla., Chapman (G); Waldo, Jan., 1871, Chapman (C); Oneco, Dec., 1897, E. W. Reasoner (U).

Widely distributed through the tropics.

13. *L. SITCHENSE* Ruprecht. Beitr. z. Pflanzenk. d. Russ. Reich.
3: 30. 1845

Prostrate stems, 20–30 cm. long, creeping along the surface of the ground or a little buried, occasionally branching and rooting with scale-like leaves, sending up frequent aerial stems which branch dichotomously several (4–6) times to form compact masses of vertical terete branches, 5–7 cm. high, with occasional stronger strobile-bearing branches usually projecting above the tuft: leaves 2 mm. \times 5 mm., lanceolate with a broad base, spreading and curving upward, thick, entire, acute, excurrent, in five rows on the branchlets; peduncles short (less than 1 cm.), very slender, with a few minute subulate bracts, or none, the strobiles then being sessile upon strong leafy branches: strobiles (0.8 \times 2.5 cm.) with broadly ovate sporophylls with erose margins and long acuminate to subulate apices nearly equaling the sporophyll.

This form has been confused with *L. sabinaefolium* Willd. and Herr Ernst Pritzel, who has kindly examined Wildenow's type sheet for us at Berlin, and has sent some fragments of the sterile branches from the two specimens it contains, assures us that both this plant and what we here regard as true *L. sabinaefolium* are a

part of Willdenow's original material from which he doubtless drew the description of *L. sabinaefolium*. The description of the latter with its expression "foliis lanceolatis acutis quadrifariis" indicates clearly the form Willdenow had in mind in naming the plant.

The plants of the Northeast are usually somewhat more slender and delicate in habit, with short (2-5 mm.) peduncles. The strobiles are sessile upon stronger leafy branches in the Northwestern forms; these leafy branches may readily be mistaken for peduncles.

Specimens have been examined as follows:

ALASKA: Back Bay, July 28, 1895, M. W. Gorman (N); Yes Bay, Aug. 21, 1895, T. Howell, no. 1730 (N), 1732 (Y).

BRITISH COLUMBIA: 49° N. Lat. Ore. Bound. Sur., Dr. Lyall, 1859. (G, lower specimen only.)

WASHINGTON: Mt. Rainier, 5000 ft., Aug., 1895, C. V. Piper (N, G); Lilly Lake, Chehalis Co., 2500 ft., Aug., 1897, F. H. Lamb, 1396 (Y); Olympic Mts., 5500 ft., C. V. Piper (G); Mt. Rainier, 1890, E. C. Smith (G); Mt. Adams, 7000 ft., Aug., 1885, W. N. Suksdorf (N); Stevens Pass, 1200 m., Aug., 1893, Sandberg & Leiberg (N U).

IDAHO: Lower Clark Fork, Oct. 7, 1895, 1820 meters, J. B. Leiberg (N).

ONTARIO: Magpie River, N. of Lake Superior, Aug., 1885, J. Macoun.

NEW YORK: Adirondack Mts., C. H. Peck (U).

MAINE: Mt. Ktaadn, Aug., 1892, S. O. Briggs (G); St. Francis, dry knoll in pasture, Aug. 7, 1893, M. L. Fernald, no. 215. (G, a good specimen with three strobiles.) (N, a smaller sterile specimen.) (U, one strobile.) Fort Kent, dry hillside pastures, June 15, 1898, M. L. Fernald (G).

LABRADOR: Square Island, Lat. 52° 44' N., Aug. 1882, J. A. Allen (C); St. Michaels, 1891, A. C. Waghorne (N, C).

14. *L. SABINAEFOLIUM* Willd. Sp. Pl. 5: 20. 1810

Prostrate stems creeping along the surface, occasionally branching and rooting, with numerous aerial stems which soon branch 3-4 or 5 times to form a loose clump of erect or straggling dorsiventral branches: leaves 1.5-2 mm. long, subulate, slightly

spreading, curved upwards, with thin apices, in four rows on the flattened terminal and subterminal branchlets, those of the lateral rows thicker and more curved than those of the upper and lower rows: peduncles (1–5 cm. long, 1 mm. thick) produced from stronger terete branches with their subulate bracts whorled or scattered: strobiles 2–3 cm. long, with broadly ovate sporophylls with short acute apices: sporangia reniform.

Specimens have been examined as follows:

MAINE: Fort Kent, "in shade," June 15, 1898, M. L. Fernald (G); Dover, "dry woods," Sept. 11, 1894, M. L. Fernald (G).

ONTARIO: Peninsular Harbor, "barren, open prairie," Sept. 16, 1896, G. S. Miller, Jr. (G).

PRINCE EDWARD ISLAND: Brackley Point, Aug., 1888, J. Macoun (U); Stanhope Road, Sept. 5, 1888, J. Macoun (C).

VERMONT: Rochester, "cold, mountain woods," Oct., 1892 (U, G); "cold, evergreen woods," Sept. 23, 1894, W. W. Eggleston (G, C).

15. *L. CHAMAECYPARISSUS* A. Br.; Doell. Rhein Fl. 36. 1843

16. *L. COMPLANATUM* L. Sp. Pl. 1104. 1753

These two species have been recently discussed and illustrated. Cf. Bull. Torr. Club, 26: 559–567, *pl.* 370, 15. N. 1899.

The northwestern forms of *L. complanatum* lack the regular compact fan-like habit of the eastern plant, but spread loosely and irregularly and are apparently glaucous. The strobiles are often solitary and in the dwarfed arctic forms of Alaska are very small upon much reduced peduncles. There are, however, at present only insufficient reasons for giving distinct specific rank to these plants. *L. complanatum*, as it grows in Scandinavia, seems to parallel the northwestern condition of the American plant.

Material has been examined as follows:

LAKE SUPERIOR: (No. 22407).

MONTANA: Upper Flathead River, July, 1883, Canby no. 399 (G); MacDonald Lake, Aug., 1892, R. S. Williams (N).

IDAHO: Lake Pend d'Oreille, Sandberg, MacDougal and Heller, July, 1892 (Y, N); Heller, 770 (G).

WASHINGTON: Stampede Pass, Henderson, June, 1892 (G).

NORTHWEST TERRITORY: Red Deer River, 53° N. Lat., July,

1881, J. Macoun (G); Head of Yukon River, June, 1883, Schwatka (G).

ALASKA: Lake Lindeman, May, 1898, R. S. Williams. A very much stunted plant 5 cm. high with strobile 1 cm. long. Specimens identical with these have been collected by Wm. Palmer in Labrador, Aug., 1887 (N).

The Mexican and Central American forms are much taller, more lax, spreading, with more irregular habit. They have been variously referred to *L. complanatum* and *L. thyoides* H. & B. (originally described from Venezuela). Without a larger array of material we hesitate to separate these plants from *L. complanatum*.

17. *L. ALPINUM* L. Sp. Pl. 1104. 1753

Prostrate stems (20–50 cm. long), creeping at or near the surface of the ground; aerial stems numerous and branching several times to form dense clumps (4–8 cm. high) of markedly dorsiventral branches with glaucous foliage; occasional strobile-bearing branches (the so-called peduncles) thicker, terete and usually projecting above the general mass: leaves of the strobile-bearing branches subulate, those of the purely vegetative branches trimorphic, those of the upper row narrowly ovate, acute, those of the lateral rows thick, with one nerve asymmetrically placed, laterally truncate, acute, falcate, curved toward the under side, those of the under row trowel-shaped: strobiles sessile (1–2 cm. long), with ovate acute sporophylls: sporangia reniform.

This plant varies not a little in the amount of spreading of the lateral leaves, although the characters otherwise are very constant. It is the most highly specialized plant of the whole genus.

Specimens have been examined as follows:

ALASKA: Disenchantment Bay, Aug., 1892, F. Funston (N); July, 1879, L. M. Turner (N); Bischoff (N); Yakutat Bay, Aug., 1892, 1175 M. F. Funston (G, C); Juneau, Aug., 1891, 3000 feet. Grace E. Cooley (C); Unalaska, July, 1872, M. W. Harrington (N, C, G), Oct., 1871 (G), Dr. Mertens (G).

BRITISH COLUMBIA: Cascade Mts., Ore. Bound. Comm., Dr. Lyall, 1859 (G upper specimen only), Griffin Lake, Aug., 1889, J. Macoun (U).

GREENLAND: Sakkertappen, July, 1886 (G); Frederickshaad, Aug., 1886; Kolderup-Rosenvinge (G).

Additional species from tropical North America are represented in American collections examined as follows:

18. *L. REFLEXUM* Lam. Encyc. Meth. Bot. **3**: 653. 1789
 MEXICO, *Vera Cruz*: Müller, 363 (C); Ex-Schlechlendal (C).
 GUATEMALA: Tuerckheim (N); J. D. Smith, 504 (C, N).
 NICARAGUA: Wright, 6 (N).
 CUBA: Wright, 953 (C).
 JAMAICA: Wilson (C); Ex-Bot. Garden (N).
 PUERTO RICO: Sintenis, 6345 (N, Y).
 GUADELOUPE: Perrin (C).
 This species is a close ally of *L. lucidulum*.

19. [*L. RIGIDUM* Gmel. Syst. Nat. **8**: 1289. 1796

Reported from mountains of Martinique and Guadeloupe, but not found in American collections.]

20. *L. VERTICILLATUM* L. fil. Suppl. 448. 1781
L. setaceum Lam. Encyc. Meth. Bot. **3**: 653. 1789.
L. acerosum Sw. Fl. Ind. Occid. **3**: 1575. 1806.

The type was described from Bourbon, but Old World material in our herbaria is insufficient to verify or disprove the above quoted citations.

- MEXICO, *Vera Cruz*: Müller, 361 (C); *Oaxaca*: Pringle, 4994 (C, N).
 CUBA: Wright, 935 (C, N).
 MARTINIQUE: Pere Duss (Y).

21. *L. FUNIFORME* Chamisso; Spring Monog. **1**: 50. 1842
 CUBA: Wright, 943 (C, N).

22. [*L. MOLLIKOMUM* Mart.; Spring Fl. Bras. **1**: 113. 1840

Reported from Guatemala, but not seen in American collections.]

23. *L. LINIFOLIUM* L. Sp. Pl. 1100. 1753
 MEXICO, *Vera Cruz*: Müller (C).
 GUATEMALA: J. D. Smith, 959 (C).
 CUBA: Wright, 934, 1825 (C, N).
 PUERTO RICO: Sintenis, 1541 (N, Y); Eggers, 8654.

24. *L. DICHOTOMUM* Jacq. Hort. Vind. **3**: 26. *pl.* 45. 1776
 MEXICO, *San Luis Potosi*: Pringle, 2976 (C, N, U), (distributed as *L. taxifolium*).
 CUBA: Wright, 944 (C, N).

25. *L. TAXIFOLIUM* Swz. Fl. Ind. Occid. **3**: 1573. 1806
 MEXICO, *Vera Cruz*: C. L. Smith, 2118 (N); Cordoba, Bourgeau (C). *Morelos*: Pringle, 7613.
 CUBA: Wright, 937 (C, N).
 JAMAICA: Caswell Grave, 3206; Ex Bot. Garden (N).
 PUERTO RICO: Sintenis, 1538 (N, Y).
 SANTO DOMINGO: Pere Duss (Y).
 GRENADA: Sherring, 36 (C).

26. *L. AQUALUPIANUM* Spring, Monog. **1**: 68. 1842
 CUBA: Wright, 936 (C).
 PUERTO RICO: Sintenis, 5432 (N, Y).
 TRINIDAD: Fendler, 107 (N).
27. [*L. SUBULATUM* Desv. Encyc. Bot. Suppl. **3**: 544. 1813
 Reported from "all tropical America" but not seen in American collections.]

28. *L. JUSSIAEI* Desv. Encyc. Bot. Suppl. **3**: 543. 1813
 JAMAICA: Purdie (C); Ex Herb. Bot. Gard. (N).

29. ***Lycopodium Fawcettii* sp. nov.**

Horizontal stems trailing giving off at intervals of 2–3 cm. lax clusters of much branched aerial stems (12–15 cm. high) of two sorts, vegetative and peduncular; the vegetative branches flattened, the ultimate divisions elongate slender and rigid (1.5 mm. wide) with four rows of appressed leaves, those of the under row reduced to a triangular tip; peduncular stems arising from near the ground, branching about six times, thick, terete, the ultimate branches the thinnest with 6–8 rows of triangular, thin, membranous tipped leaves; many of the peduncular stems produce ultimately sessile strobiles 2–3 cm. long which scarcely exceed the negative branches, sporophylls broader than long, very abruptly contracted into a subulate tip, sporangia reniform.

JAMAICA: ex herb. Botanical Garden, 1885 (N) (U. S. Nat. Herb 22368=type); Wilson, 1863 (C), a form with abnormal peduncular stems.

SANTO DOMINGO: Wright, Parry, and Brummel, no. 37, 1871 (N, C). Apparently a much more elongate and slender form; Eggers, no. 2270 (C), similar to Wilson's Jamaica form noted above.

This plant is related to *L. complanatum* but is entirely distinct from that species.

Explanation of Plates

PLATE 2

All the figures are drawn to the same scale.

FIG. 1. *Lycopodium sabinaefolium*. A portion of a branch, showing the spreading and incurved lateral leaves.

FIG. 2. The same, lateral view. The leaves of the upper and lower rows are seen to be equally developed and spreading.

FIG. 3. *L. alpinum*. Under side of a part of a branch.

FIG. 4. Lateral view of the same

FIG. 5. *L. Sitchense*. A portion of a branch. Leaves in five rows.

FIG. 6. *L. porophyllum*. Sporophyll with sporangium.

FIG. 7. " Leaf.

FIG. 8. *L. Selago*. Leaf.

FIG. 9. " Leaf.

FIG. 10. " Sporophyll.

FIG. 11. *L. lucidulum*. Sporophyll.

FIG. 12. " "

FIG. 13. " Leaf.

PLATE 3

FIG. 14. *L. adpressum*. Transverse section of stem through hibernating region.

FIG. 15. " Transverse section of stem.

FIG. 16. " Leaf.

FIG. 17. " Leaf from peduncle.

FIG. 18. " Sporophyll.

FIG. 19. *L. alopecuroides*. Transverse section of stem.

FIG. 20. " Transverse section of stem through hibernating region.

FIG. 21. " Leaf.

FIG. 22. " Sporophyll.

FIG. 23. *L. inundatum*. Leaf.

FIG. 24. " Leaf.

FIG. 25. " Sporophyll.

FIG. 26. " Transverse section of stem.

FIG. 27. *L. pinnatum*. Transverse section of stem.

FIG. 28. " Leaf.

FIG. 29. " Sporophyll.

FIG. 30. " Leaf.

PLATE 4

L. pinnatum and *L. alopecuroides* from the Chapman Herbarium (C); the former representing Chapman's type specimen.